Asphalt Materials

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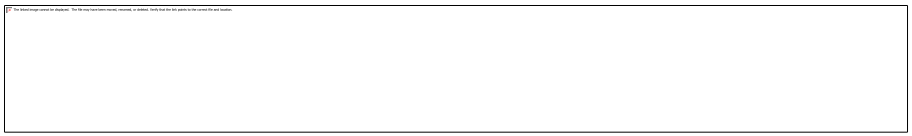
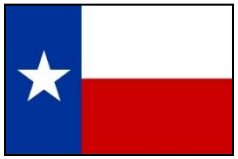
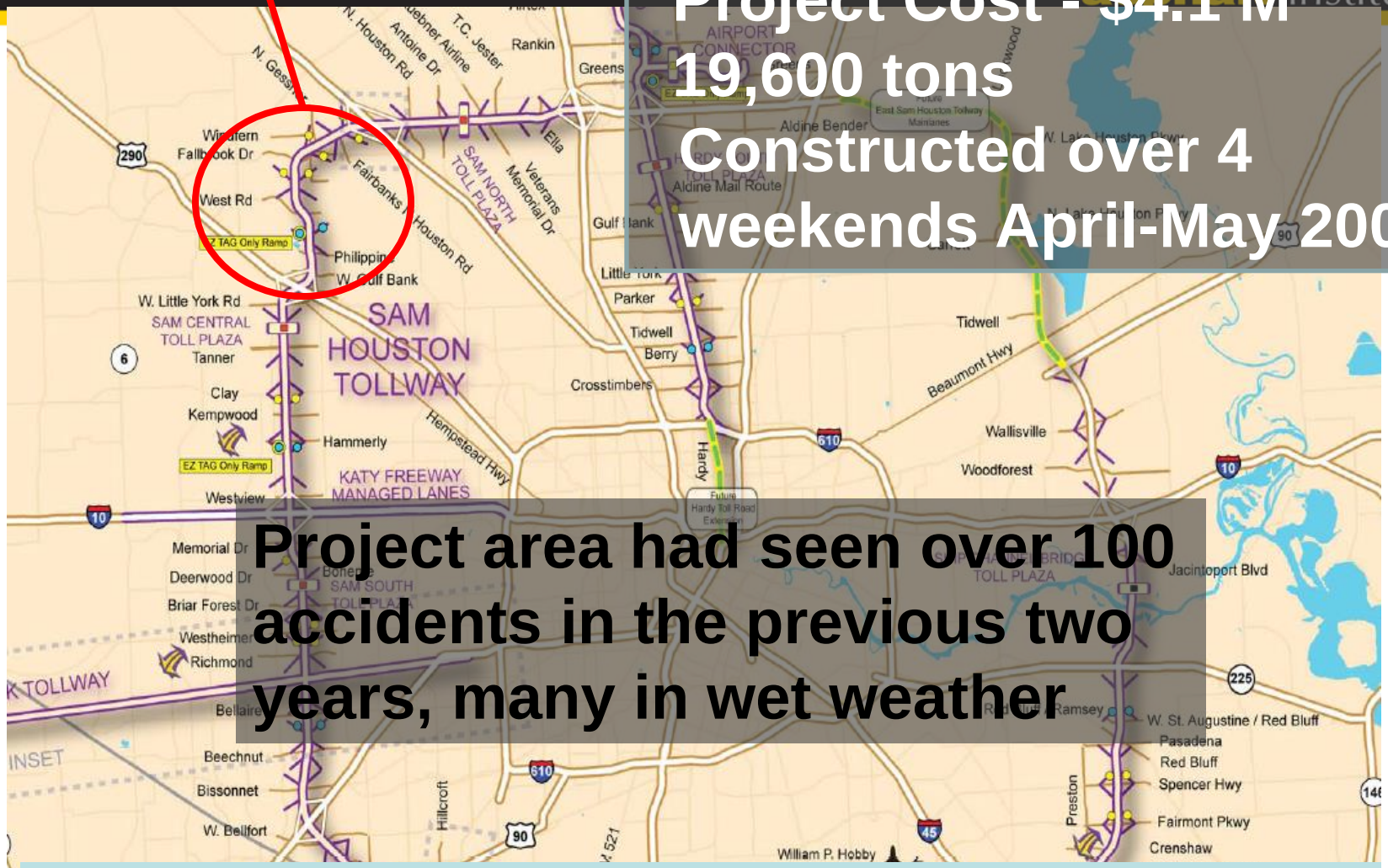




Project Location

Project Length = 5 miles
Project Cost - $4.1 M
19,600 tons
Constructed over 4 weekends April-May 2009

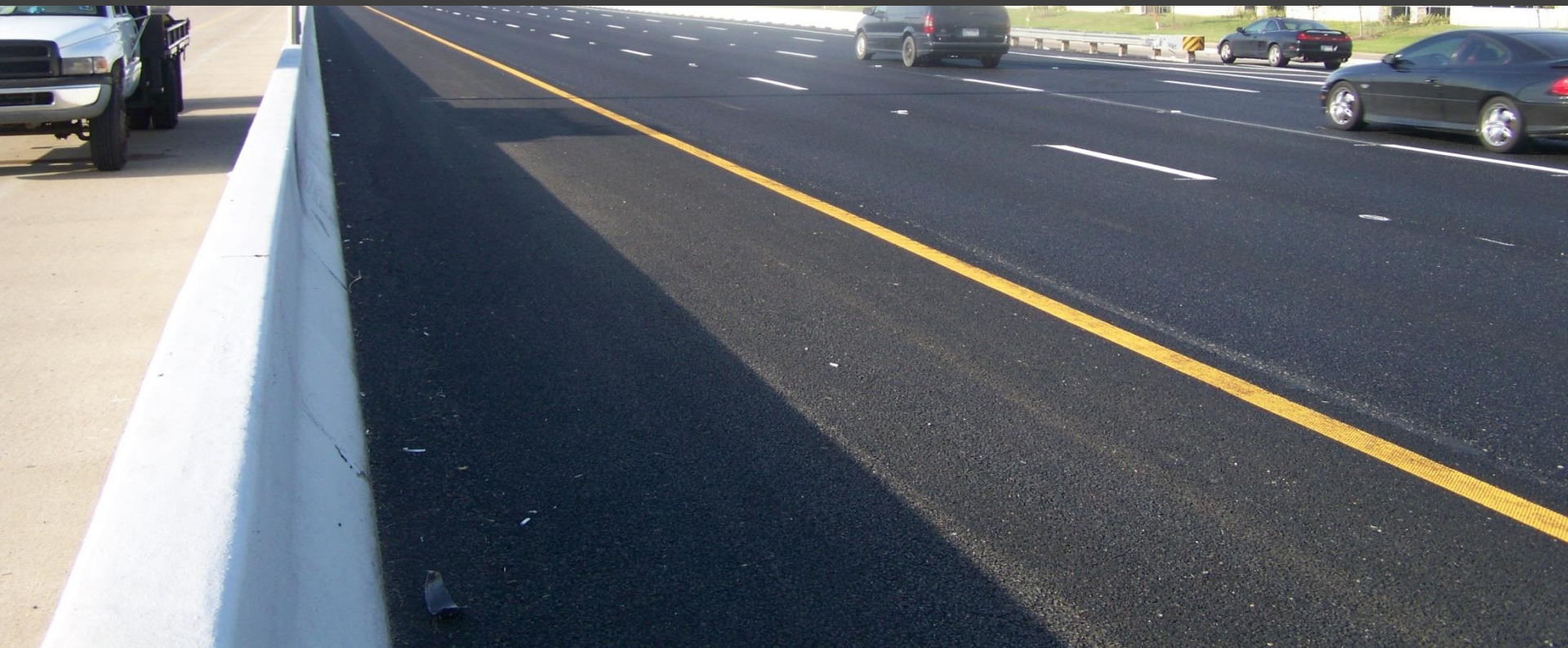


Project area had seen over 100 accidents in the previous two years, many in wet weather

Solution: Asphalt Permeable Friction Course

HCTRA Engineer Quinton Alberto reported that they have been pleasantly surprised with:

- **the ease of construction**
- **the short time to complete the project**
- **the aesthetically pleasing appearance of the project**
- **the performance in rain**
- **the quieter road noise**



Performed a quick and easy noise study this morning (July 10, 2013)

Digital Sound Level Meter
Radio Shack - $49.99

Monitored PC Concrete section over a 5-minute period and recorded minimum and maximum readings

Min – 85 dB
Max – 96 dB

Digital Sound Level Meter
Radio Shack - $49.99

Monitored Asphalt PFC overlay section over a 5-minute period and recorded minimum and maximum readings

Min – 78 dB
Max – 90 dB

min 7 dB lower
max 6 dB lower

Digital Sound Level Meter
Radio Shack - $49.99

OSHA Daily Permissible Noise Level Exposure	
Hours per day	Sound level
8	90dB
6	92dB
4	95dB
3	97dB
2	100dB
1.5	102dB
1	105dB
.5	110dB
.25 or less	115dB

Classifications of Asphalt

- **Cutbacks**
- **Emulsions**
- **Asphalt Cement (Binder)**

Cutback Asphalt

- Paving asphalt liquefied by blending with petroleum solvents
- Resulting material can be sprayed/mixed at lower temperatures
- Primary uses:
  - penetrating prime coat
  - binders for storable cold mix asphalt

Types of Cutback Asphalt

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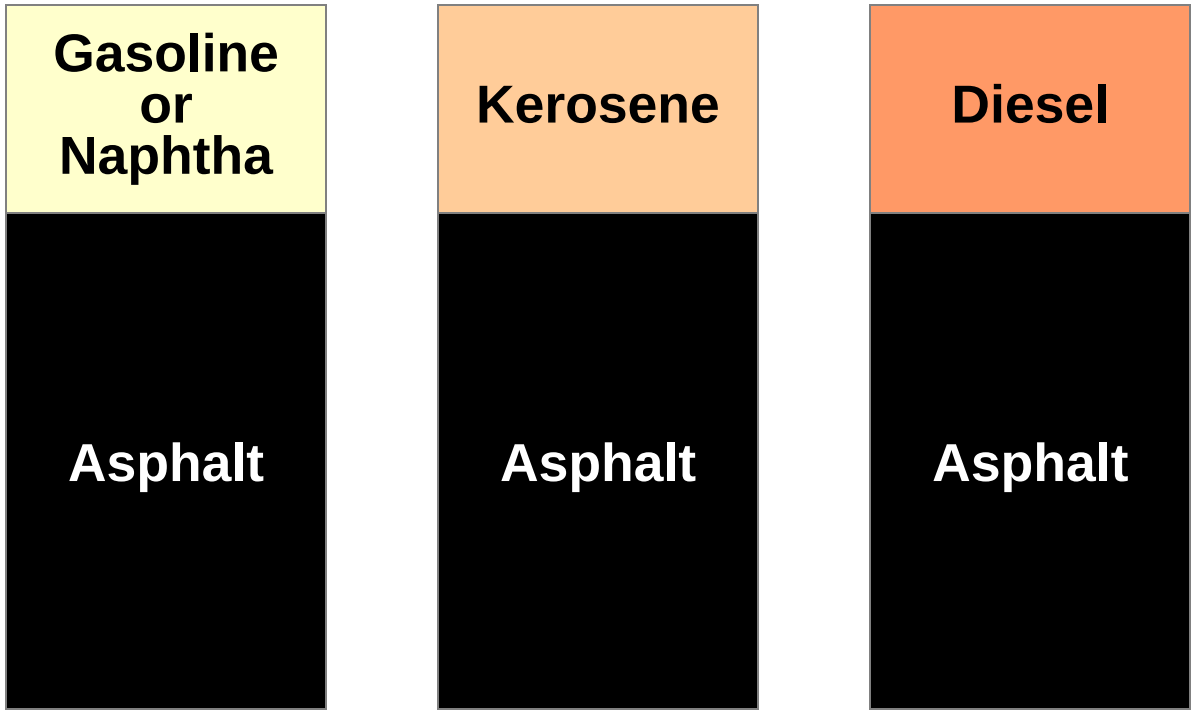
Rapid Curing (RC) ASTM D 2028	Medium Curing (MC) ASTM D 2027	Slow Curing (SC) ASTM D 2026
Gasoline or Naphtha	Kerosene	Diesel
Asphalt	Asphalt	Asphalt



Grades of Cutback Asphalt

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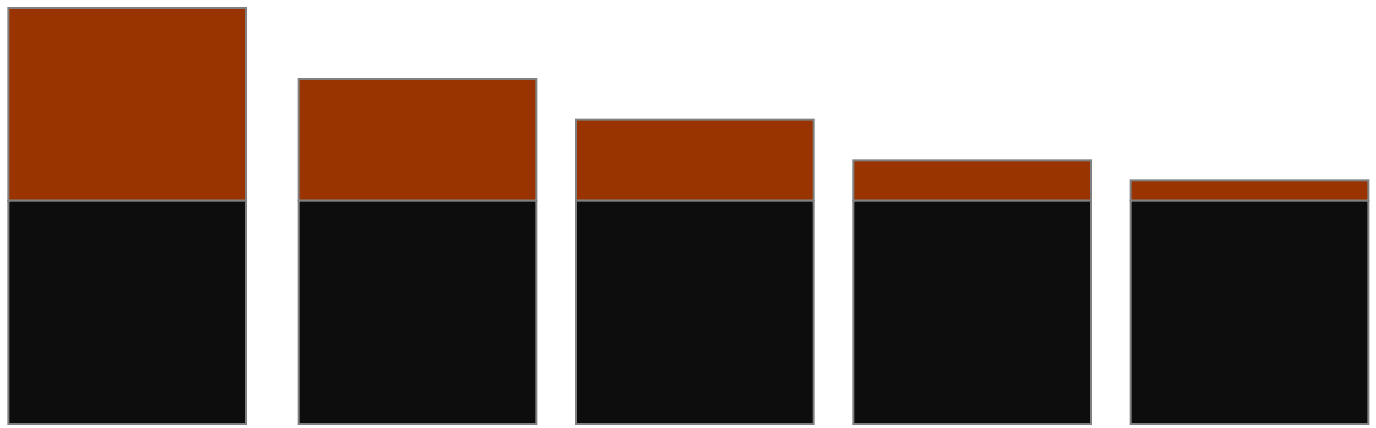
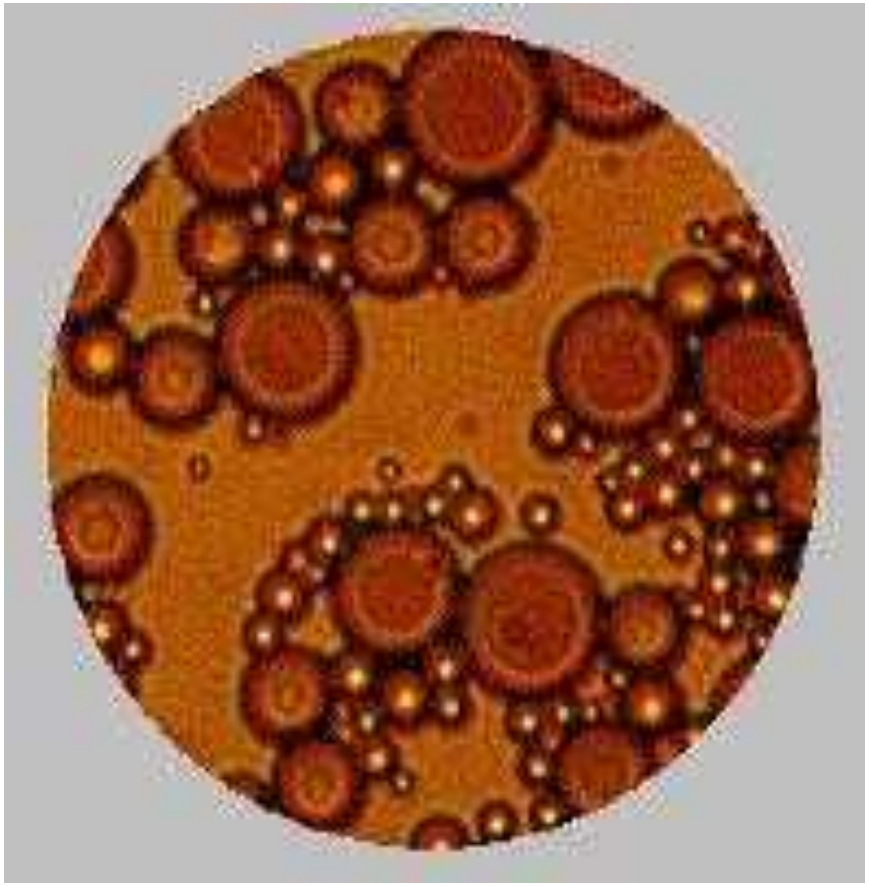


Kinematic Viscosity mm^2/s

MC-30	MC-70	MC-250	MC-800	MC-3000
30 - 60	70 - 140	250 - 500	800 - 1600	3000 - 6000

Asphalt Emulsions

- Microscopic asphalt droplets suspended in water.
- Mostly 1-5 μm diameter
- Emulsifiers or surfactants hold these droplets in suspension.



Asphalt Emulsions

The purpose of diluting the binder with water is to lower the viscosity.

This allows the emulsion to be shot onto the roadway surface at much lower temperatures than straight binder.

If the emulsifying agent causes the particles to bear a negative charge, the emulsion is said to be *anionic*.

If the emulsifying agent causes the particles to bear a positive charge, the emulsion is said to be *cationic*.

Asphalt Emulsions

The process in which the binder globules begin to coalesce and the water evaporates is called *breaking*.

The amount of binder left after the water evaporates is called the *residual asphalt*.

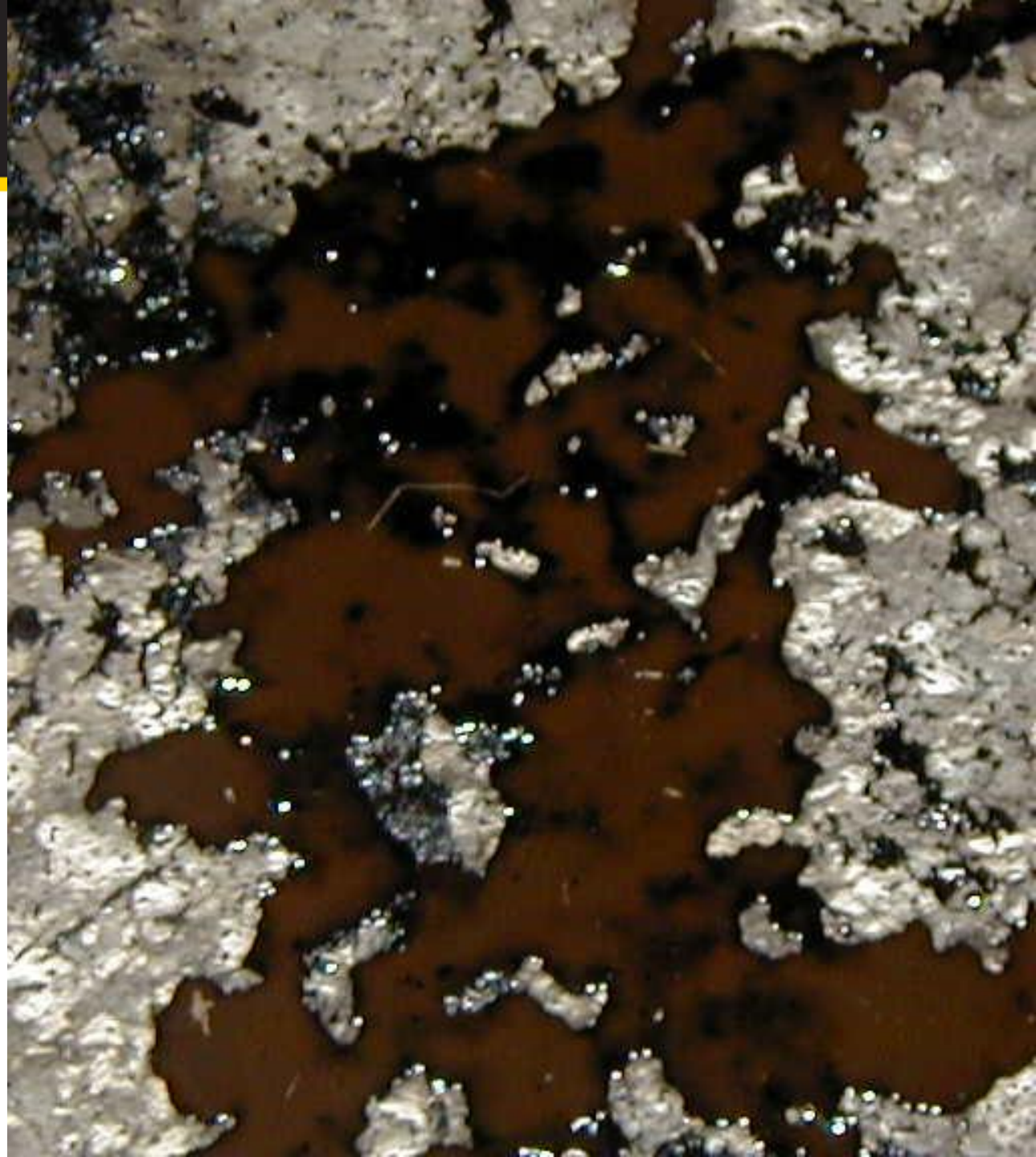
The residual asphalt is expressed as a percentage of the emulsion.

Both the amount and type of water and emulsifying agent mixed with the binder affect the evaporation rate.

Emulsion

"Un-broken" emulsion is brown

"Broken" emulsion is black



Negatively- Charged Emulsions are classified into 3 types

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RS (Rapid Setting)

MS (Medium Setting)

SS (Slow Setting)

Positively- Charged Emulsions are also classified into 3 types

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CRS (Rapid Setting)

CMS (Medium Setting)

CSS (Slow Setting)

Additional Nomenclature

QS = Quick Set

HF = High Float

1 = Binder residue = 60% Minimum

2 = Binder Residue = 65% Minimum

h = Hard Pen Asphalt Base

s = Soft Pen Asphalt Base or sometimes Solvent

l and/or p = Latex and/or Polymer

Asphalt Emulsions

Anionic emulsions (negatively charged) typically bond best with positively charged aggregates (limestones, dolomites).

Cationic emulsions (positively charged) typically bond best with negatively charged aggregates (granites, sandstones).

Asphalt Emulsions

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Emulsions are further separated into different grades depending on various factors including viscosity, base asphalt type, and amount of residual asphalt .

The most common uses of emulsions are for chip seals, tack coats, and fog seals.

Asphalt Binders

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The term "binder" covers both neat (unmodified) and modified asphalt cements, but doesn't include emulsions and cutbacks.

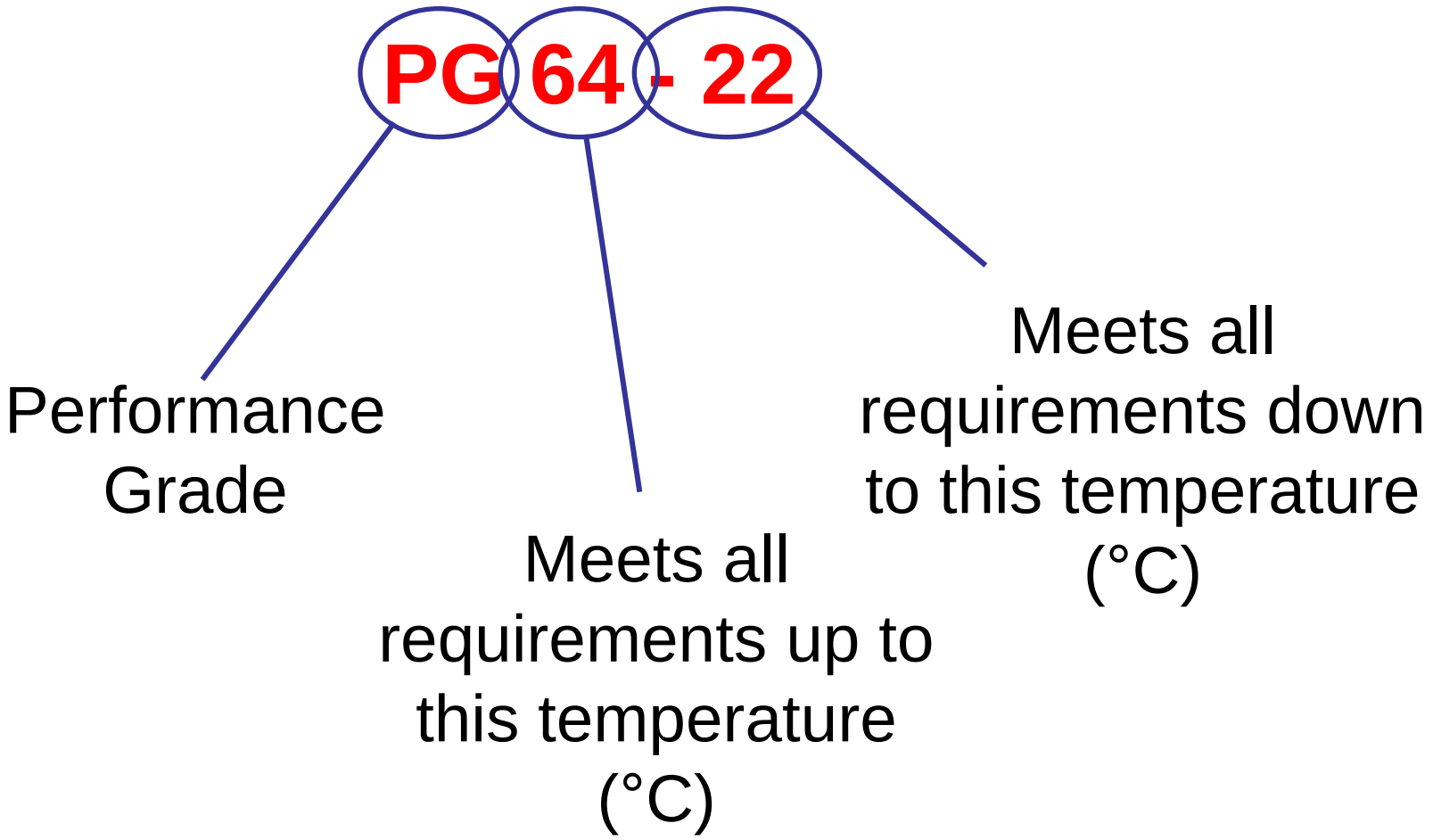
Binders are the "glue" that holds the aggregate together in HMA.

Unlike emulsions and cutbacks, binders are typically required to be heated to over 300°F for use, unless modified for use as Warm Mix Asphalt (WMA).

Polymers can be added to the binder to enhance their high temperature performance.

Superpave Asphalt Binder Specifications

The grading system is based on Climate



High Temperature @ 98% Reliability

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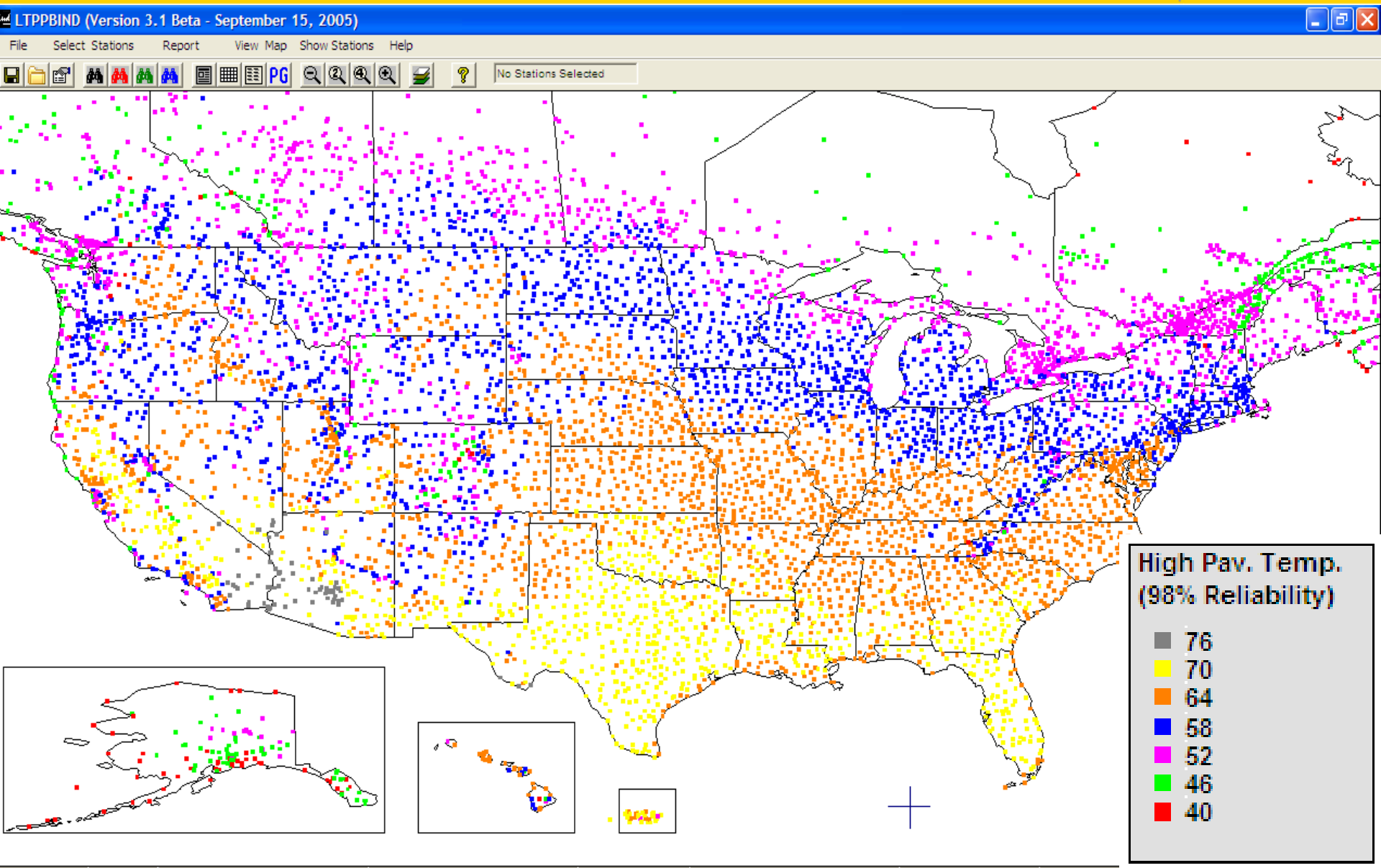

Low Temperature @ 98% Reliability

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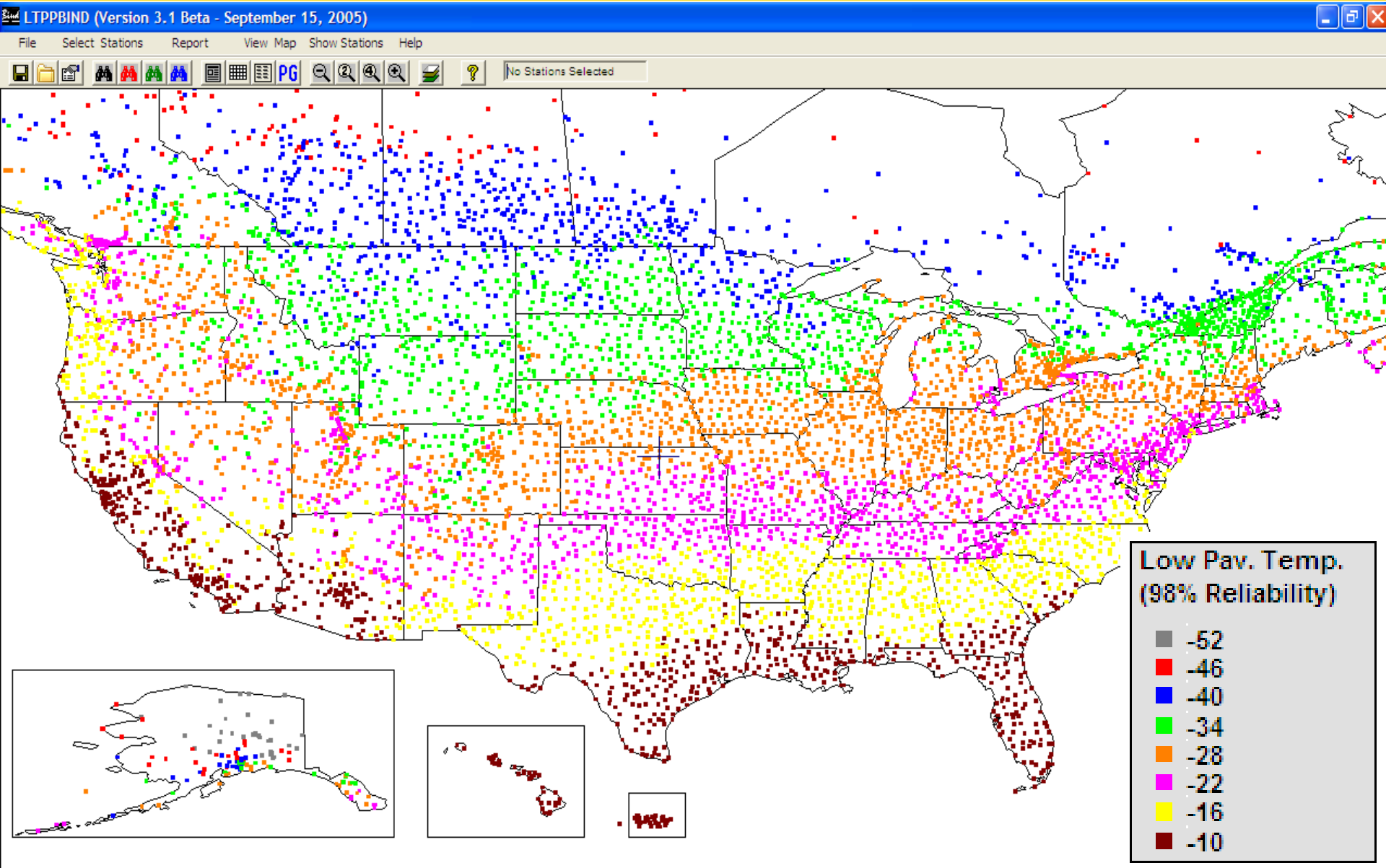
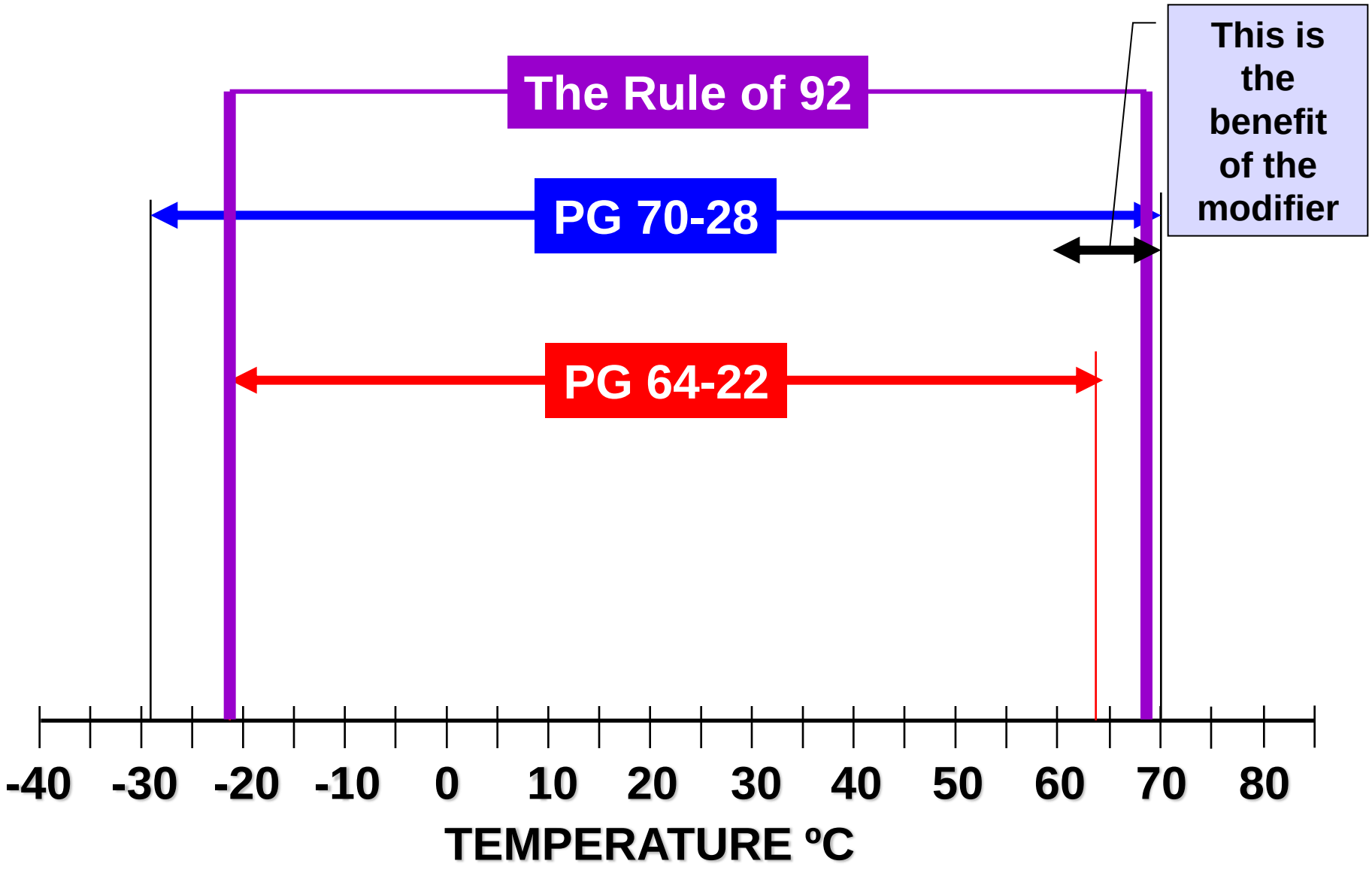


PG Binder Grades

PG 64-22 Probably Unmodified

PG 70-28 Probably Modified



Asphalt Description and Sources

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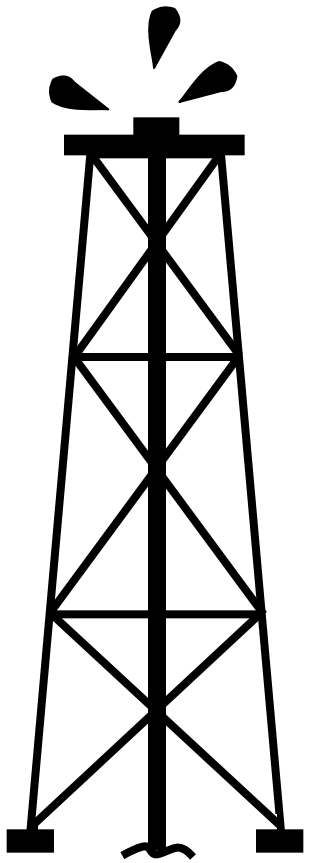
Asphalt Cement or Asphalt Binder

- Black, cementitious, waterproof material
- Originally mined from a natural lake (still operating today: Lake Asphalt of Trinidad and Tobago)
- Most asphalt today comes from the refining process

Not All Crudes Are The Same

- **Source**
  - Continents, Countries, States, Fields
  - Blends
- **Viscosity**
  - Heavy, Medium, & Light
- **Asphaltenes**
  - Content, Size, Polarity
- **Sulfur**
  - Sweet, sour



Not All Crudes Are The Same

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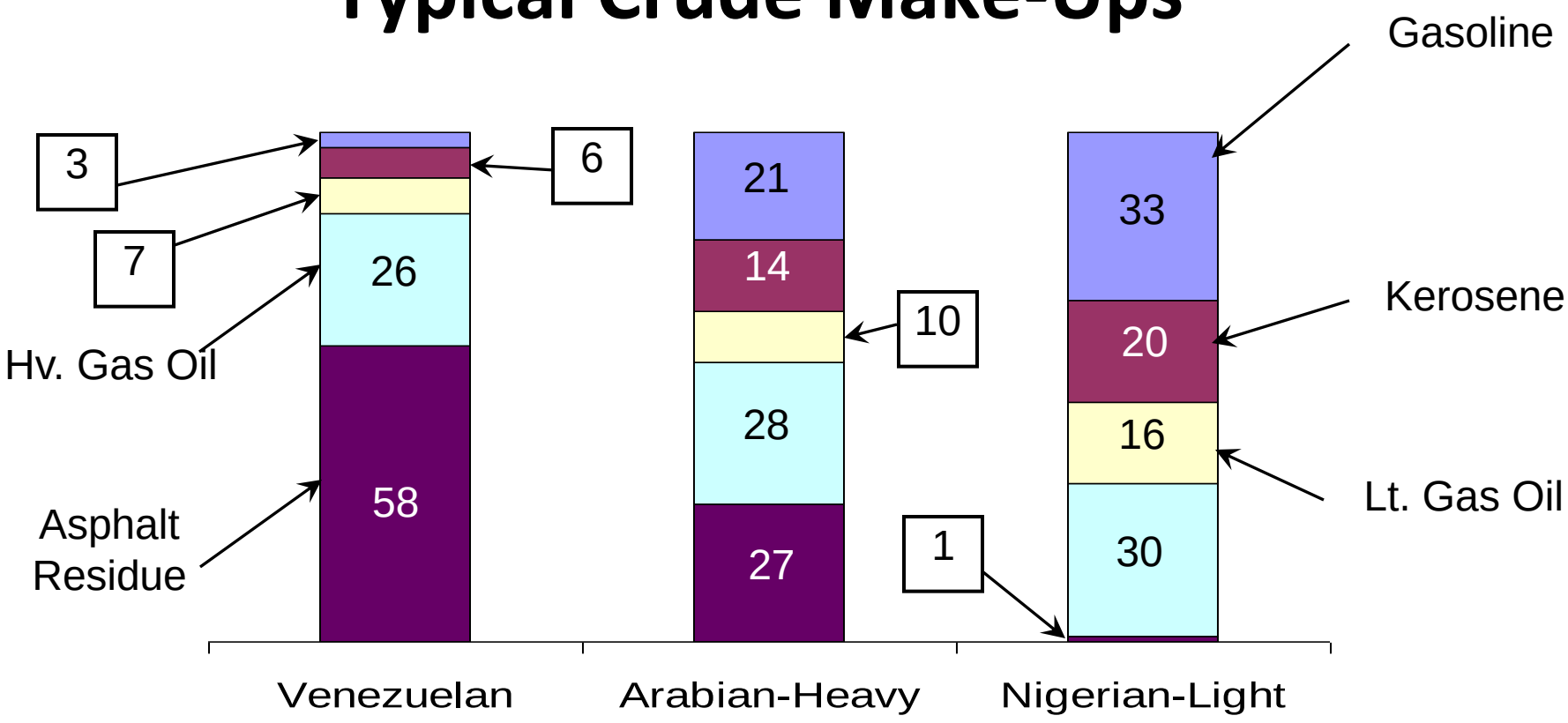
Typical Crude Make-Ups



Asphalt Behavior Depends On:

- Temperature
- Time of Loading
- Aging (properties change with time)

Asphalt Behavior at Varying Temperatures

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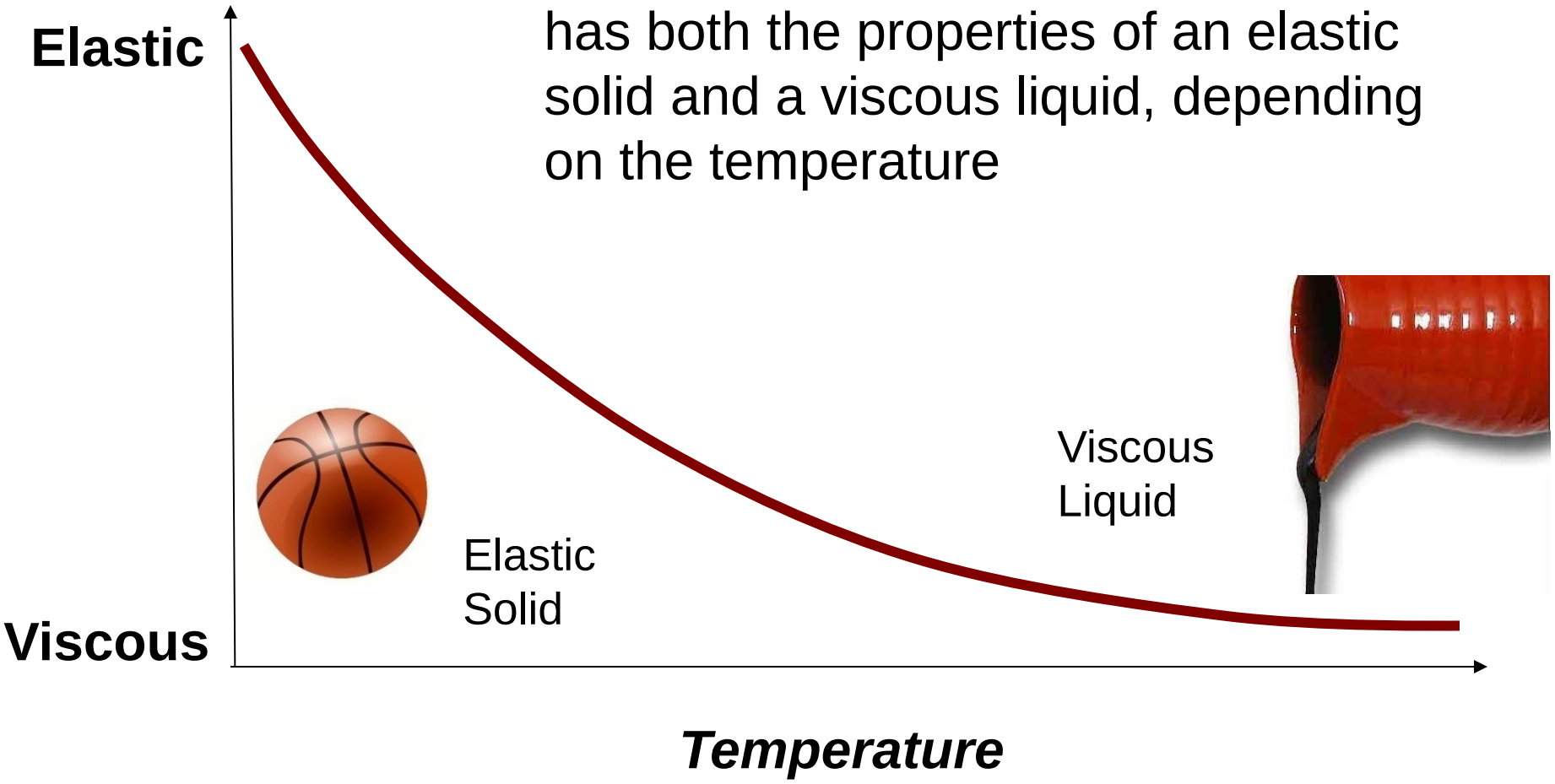
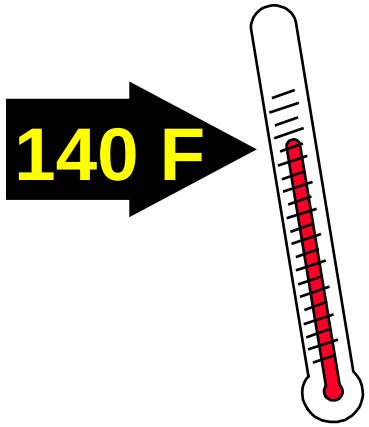
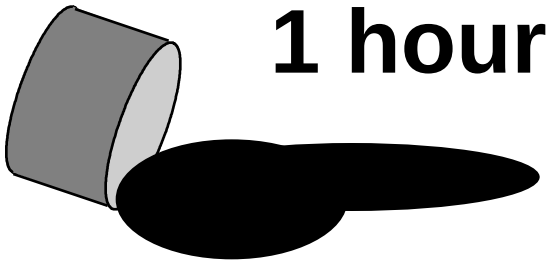
Asphalt is a *viscoelastic* material that has both the properties of an elastic solid and a viscous liquid, depending on the temperature

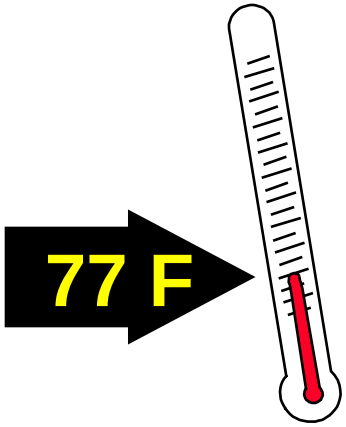


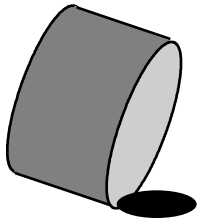
Asphalt Flow Behavior



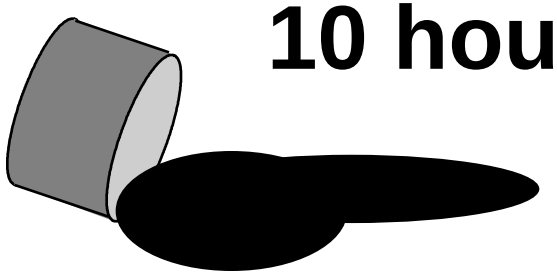


1 hour





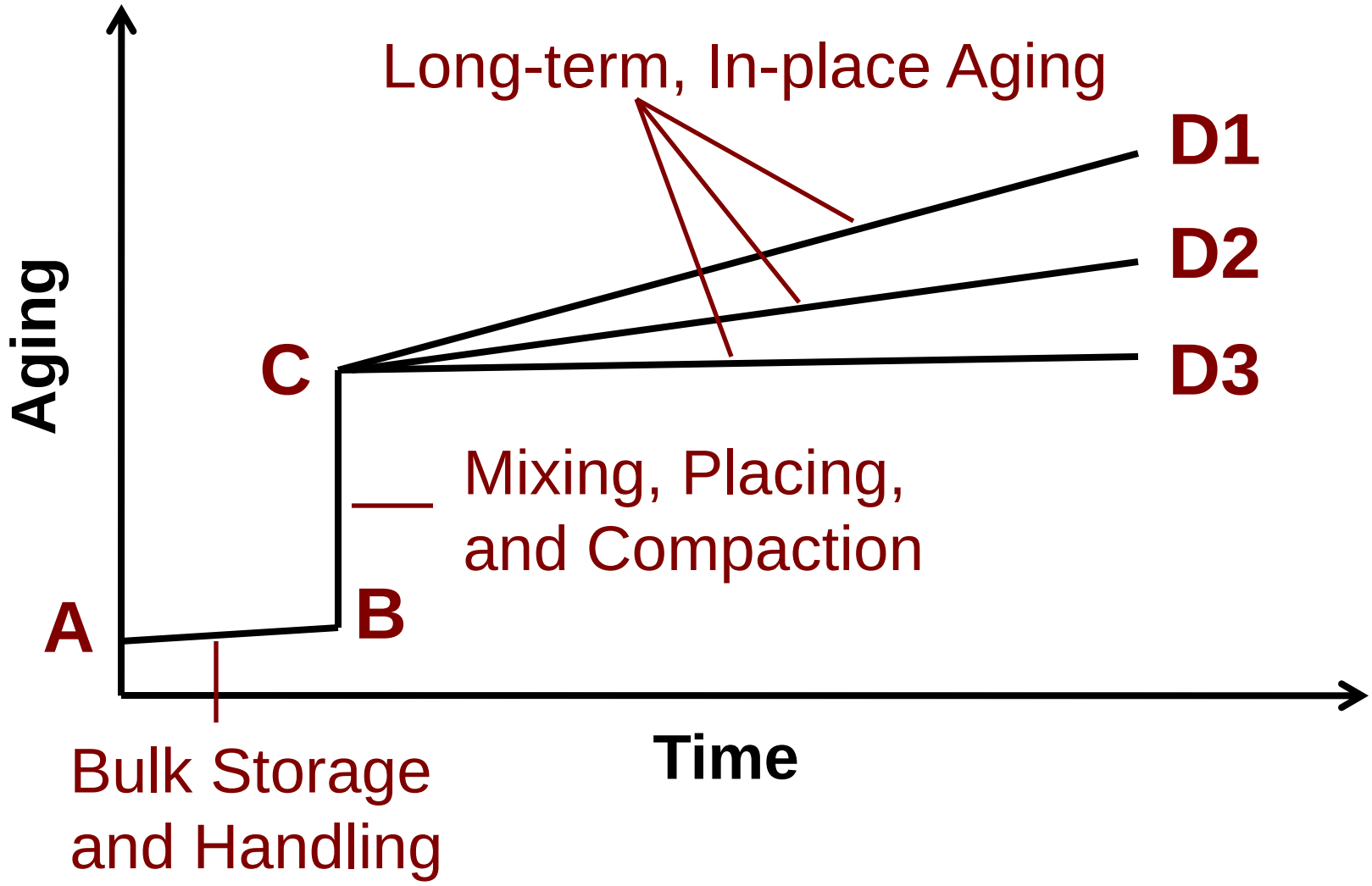
1 hour



10 hours

Time of Loading

Asphalt aging over the pavement life



High Temperature Behavior

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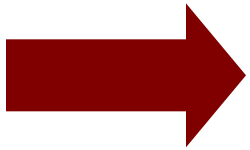
- **High in-service temperature**
  - Desert climates
  - Summer temperatures
- **Sustained loads**
  - Slow moving trucks
  - Intersections



Viscous Liquid

Low Temperature Behavior

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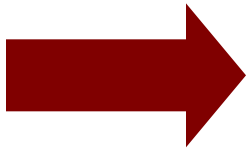
- **Low Temperature**
  - Cold climates
  - Winter
- **Rapid Loads**
  - Fast moving trucks



Elastic Solid

“Ideal” Asphalt Binder

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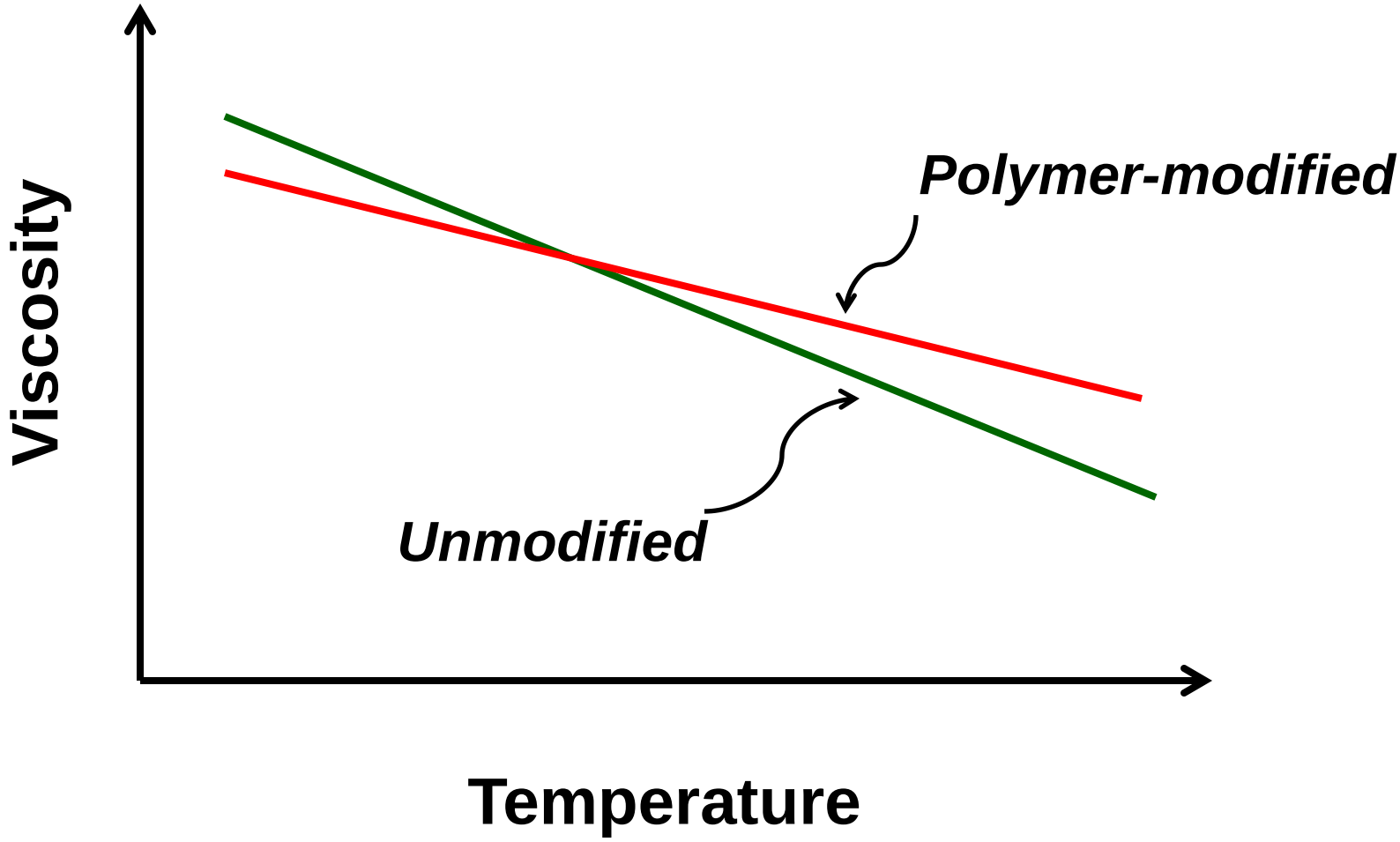
- **Low stiffness at construction temperature**
- **High stiffness at high in-service temperature**
- **Low stiffness at low in-service temperature**
- **Excellent long-term durability**

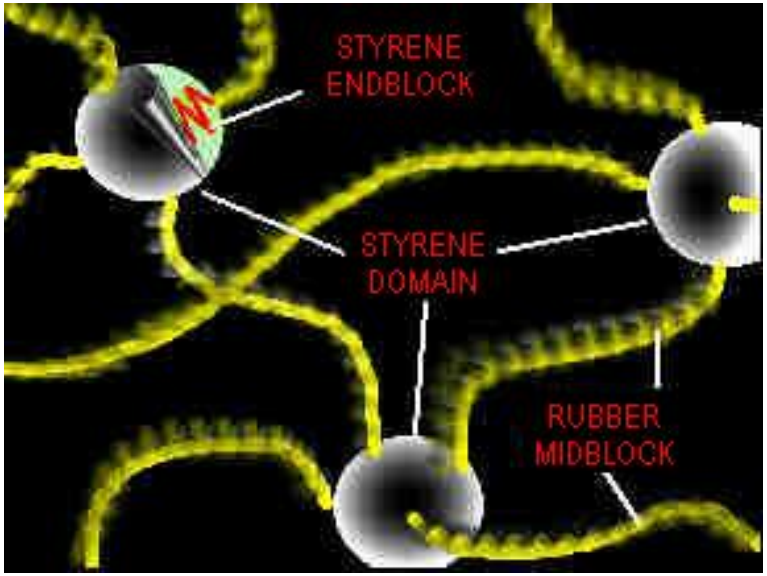
Polymer-modified Asphalt Binder

General Performance



Polymers

- Elastomers
- Plastomers
- Combinations



poly • mer

“many parts”

Image courtesy Infrapave

Elastomers

- Natural Latex Rubber
- Synthetic Latex
  - Styrene-butadiene (SB)
- Block Copolymer
  - Styrene-butadiene-styrene (SBS)
- Reclaimed Rubber

Image courtesy Injectec.com

Plastomers

- Polyethylene
- Polypropylene
- Ethyl-vinyl-acetate (EVA)
- Polyvinyl-chloride (PVC)

EVA is a plastic that is used to create stiffer insoles for your shoes

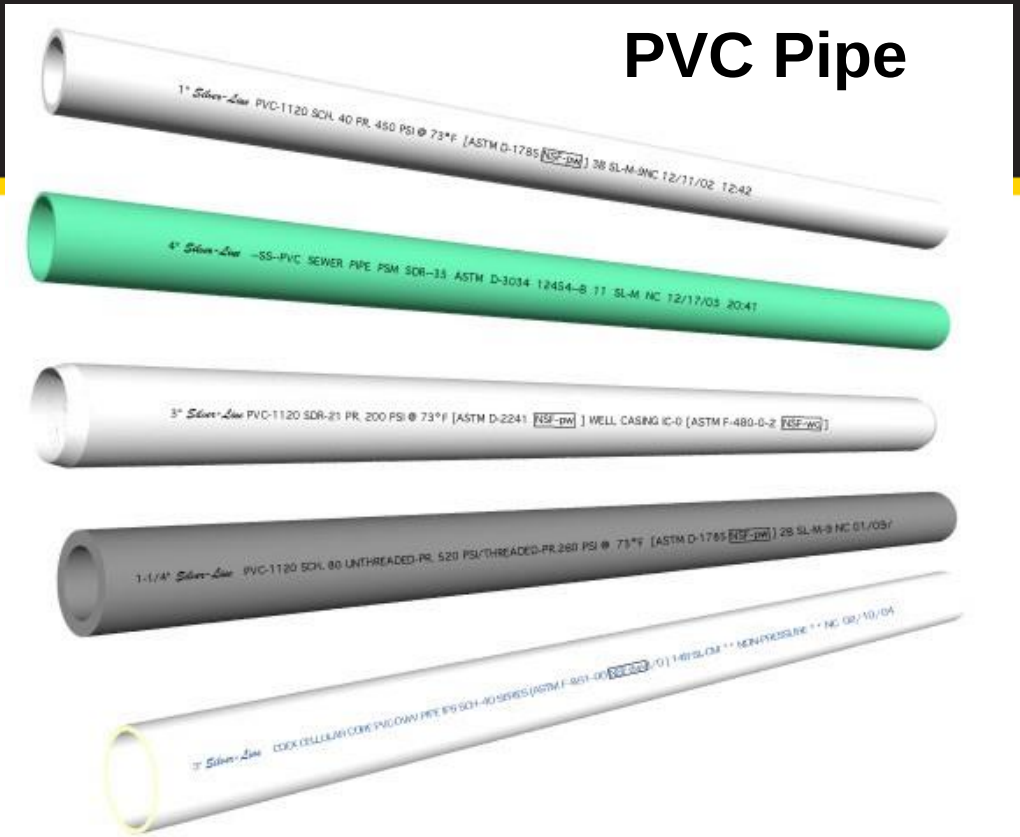


Image courtesy slpipe.com

Image courtesy cyclingfitness.com

Quantifying the Effects of PMA for Reducing Pavement Distress

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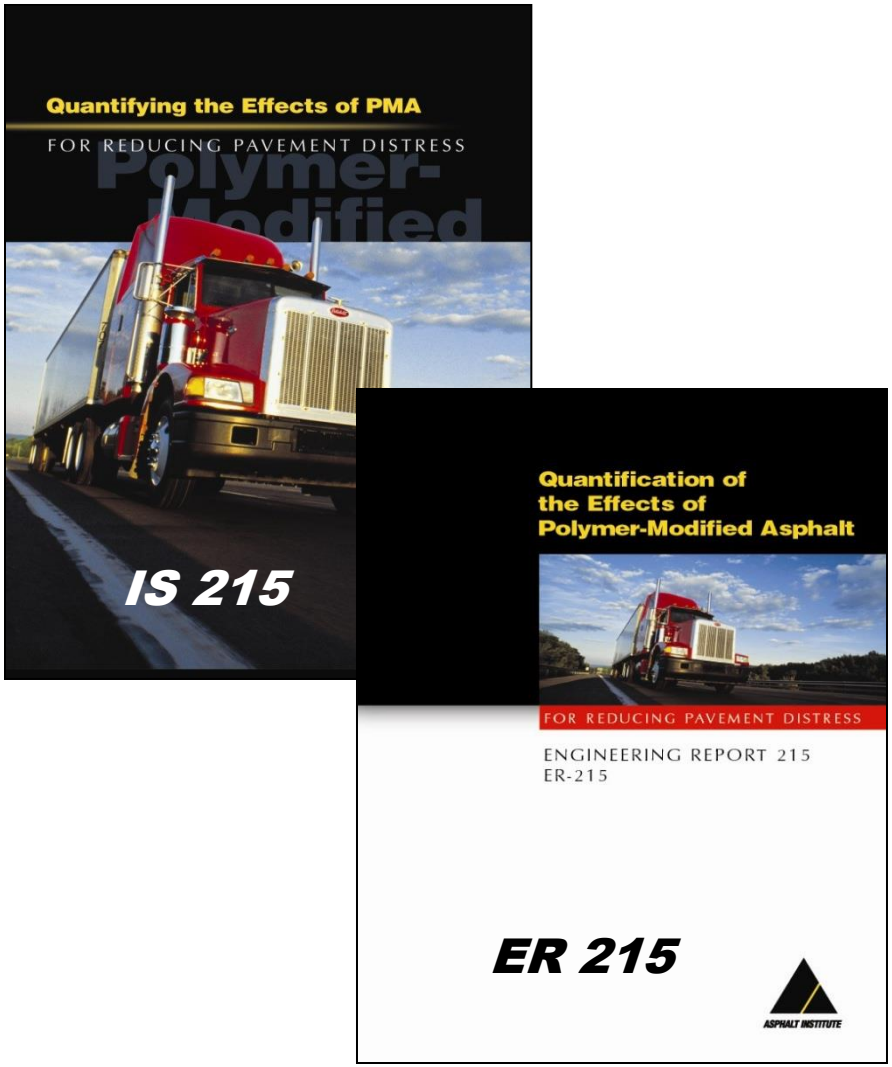

This study (published in Feb 2005) used national field data to determine enhanced service life of pavements containing polymer modified binders versus conventional binders. The data is from a variety of climates and traffic volumes within North America.

Direct Comparisons – Rutting

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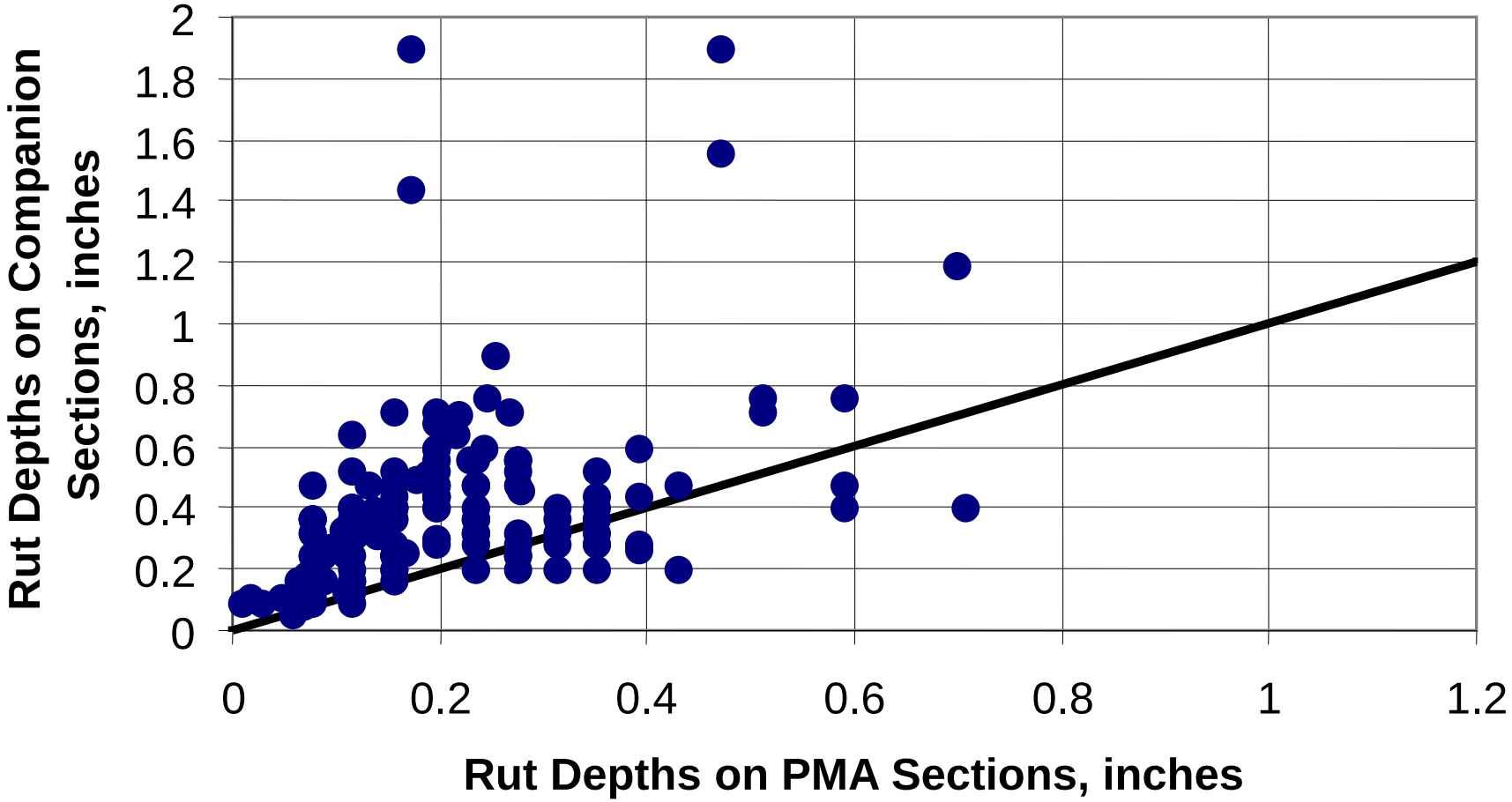
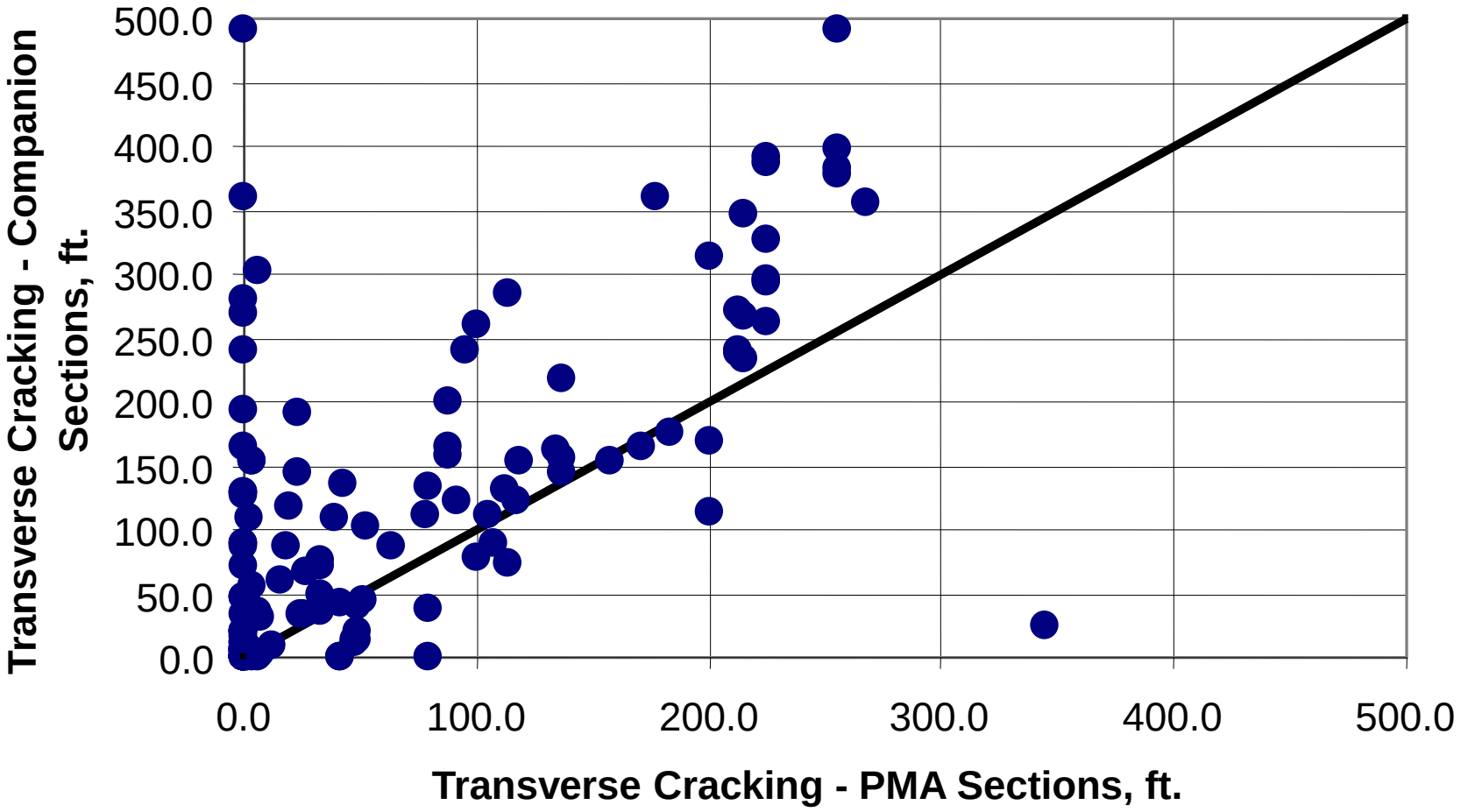
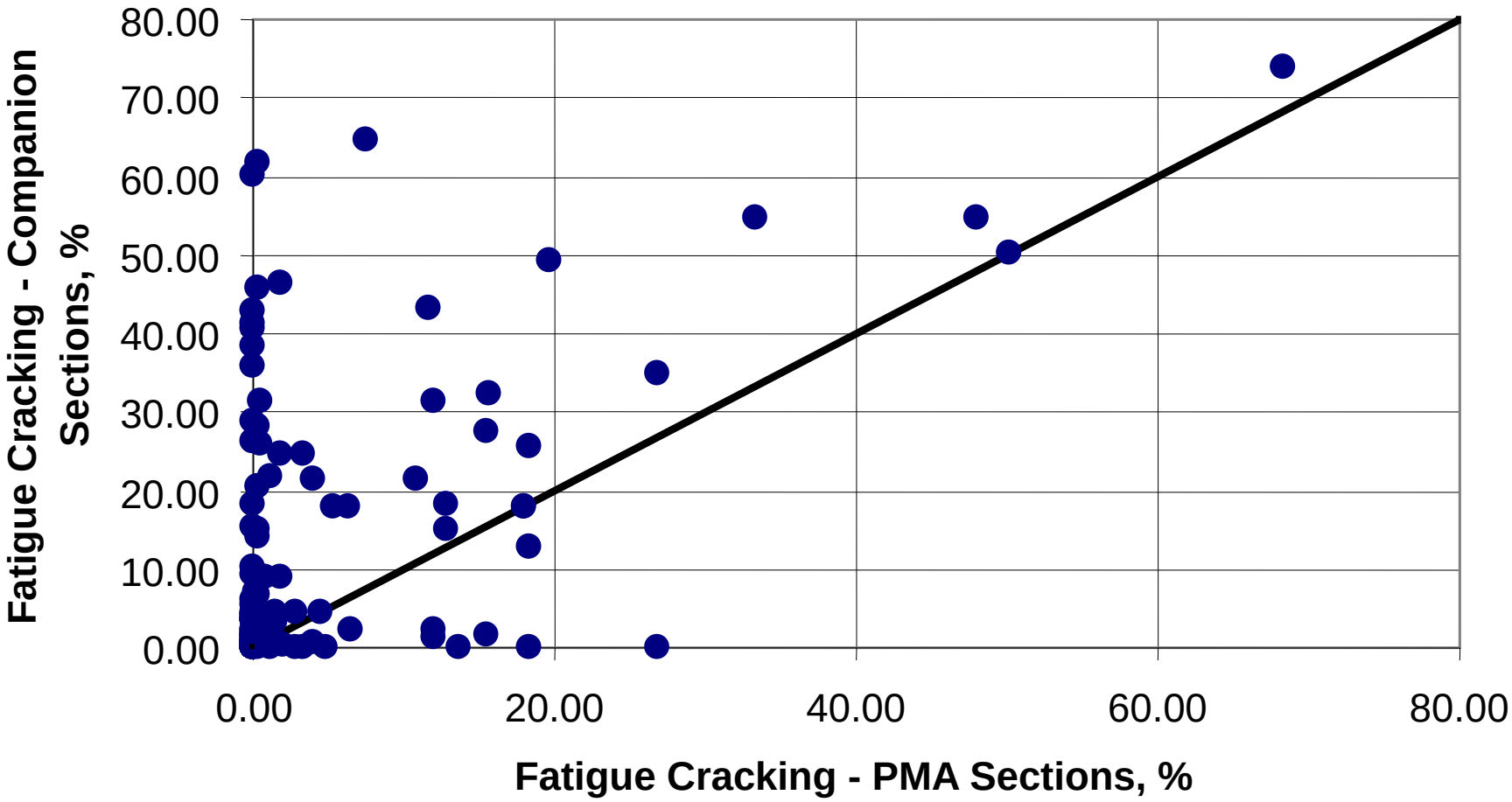


Distress Comparisons – Transverse Cracking



Distress Comparisons – Fatigue Cracking



When would a polymer-modified asphalt typically be used?

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AASHTO M 323 - Table 1

	Adjustment to High-Temp Grade		
	Traffic Load Rate		
ESALs (M)	Standing	Slow	Standard
< 0.3	-	-	-
0.3 - < 3	2	1	-
3 - < 10	2	1	-
10 - < 30	2	1	-
≥ 30	2	1	1

*** TxDOT guidance very similar, but less structured**

Asphalt Materials

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Questions?